

Investigation of eigenvibrations of a loaded bar

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Abstract

© The Authors, published by EDP Sciences, 2018. The differential eigenvalue problem describing eigenvibrations of a bar with fixed ends and attached load at an interior point is investigated. This problem has an increasing sequence of positive simple eigenvalues with limit point at infinity. To the sequence of eigenvalues, there corresponds a complete orthonormal system of eigenfunctions. We formulate limit differential eigenvalue problems and prove the convergence of the eigenvalues and eigenfunctions of the initial problem to the corresponding eigenvalues and eigenfunctions of the limit problems as load mass tending to infinity. The original differential eigenvalue problem is approximated by the finite difference method on a uniform grid. Error estimates for approximate eigenvalues and eigenfunctions are established. Theoretical results are illustrated by numerical experiments for a model problem. Investigations of this paper can be generalized for the cases of more complicated and important problems on eigenvibrations of beams, plates and shells with attached loads.

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References

- [1] A. V. Goolin, S. V. Kartyshov, *Surv. Math. Ind.* 3, 29-48 1993
- [2] T. Betcke, N. J. Higham, V. Mehrmann, C. Schröder, F. Tisseur, *ACM Trans. Math. Software* 39, 7 2013
- [3] V. A. Kozlov, V. G. Maz'ya, J. Rossmann, *Spectral Problems Associated with Corner Singularities of Solutions to Elliptic Equations* (. AMS, Providence, 2001)
- [4] S. I. Solov'ev, *Lobachevskii J. Math.* 37, 597-609 2016
- [5] S. I. Solov'ev, *Izv. Vyssh. Uchebn. Zaved. Mat.* 10, 71-74 1985
- [6] A. Ruhe, *SIAM J. Numer. Anal.* 10, 674-689 1973
- [7] V. Mehrmann, H. Voss, *GAMM-Mit.* 27, 1029-1051 2004
- [8] F. Tisseur, K. Meerbergen, *SIAM Rev.* 43, 235-286 2001
- [9] D. Kressner, *Numer. Math.* 114, 355-372 2009
- [10] X. Huang, Z. Bai, Y. Su, *J. Comput. Math.* 28, 218-234 2010
- [11] H. Schwetlick, K. Schreiber, *Linear Algebra Appl.* 436, 3991-4016 2012
- [12] W.-J. Beyn, *Linear Algebra Appl.* 436, 3839-3863 2012
- [13] A. Leblanc, A. Lavie, *Eng. Anal. Bound. Elem.* 37, 162-166 2013
- [14] X. Qian, L. Wang, Y. Song, *J. Comput. Appl. Math.* 290, 268-277 2015
- [15] A. V. Kregzhde, *Differ. Uravn.* 17, 1280-1284 1981
- [16] S. I. Solov'ev, *Comput. Math. Math. Phys.* 32, 579-593 1992
- [17] R. Z. Dautov, A. D. Lyashko, S. I. Solov'ev, *Differ. Equations* 27, 799-806 1991
- [18] S. I. Solov'ev, *Differ. Equations* 50, 947-954 2014
- [19] S. I. Solov'ev, *Differ. Equations* 51, 934-947 2015

- [20] S. I. Solov'ev, Differ. Equations 30, 1138-1146 1994
- [21] S. I. Solov'ev, Differ. Equations 38, 752-753 2002
- [22] S. I. Solov'ev, Differ. Equations 48, 1028-1041 2012
- [23] S. I. Solov'ev, Appl. Numer. Math. 93, 206-214 2015
- [24] I. B. Badriev, G. Z. Garipova, M. V. Makarov, V. N. Paymushin, Res. J. Appl. Sciences 10, 428-435 2015
- [25] I. B. Badriev, L. A. Nechaeva, PNRPU Mech. Bull. 3, 37-65 2013
- [26] I. B. Badriev, M. V. Makarov, V. N. Paimushin, Proc. Engin. 150, 1050-1055 2016
- [27] I. B. Badriev, G. Z. Garipova, M. V. Makarov, V. N. Paimushin, R. F. Khabibullin, Lobachevskii J. Math. 36, 474-481 2015
- [28] I. B. Badriev, M. V. Makarov, V. N. Paimushin, Russ. Math. 59, 57-60 2015
- [29] I. B. Badriev, M. V. Makarov, V. N. Paimushin, Proc. Engin. 150, 1056-1062 2016
- [30] I. B. Badriev, V. V. Banderov, V. L. Gnedenkova, N. V. Kalacheva, A. I. Korablev, R. R. Tagirov, Appl. Math. Sciences 9, 5697-5705 2015